ESTABLISHMENT OF *RHINOCYLLUS CONICUS* (COLEOPTERA: CURCULIONIDAE) ON MUSK THISTLE IN TENNESSEE[1]

Paris L. Lambdin, Jerome F. Grant[2]

ABSTRACT: The head weevil, *Rhinocyllus conicus,* was reintroduced into Tennessee in 1989 and released at 11 sites along the interstate highway system in eastern and middle Tennessee for control of musk thistle, *Carduus thoermeri.* One new release site was added in 1990. In 1991 and 1992, weevils were released at more than 60 sites in 13 additional counties each year. Head weevils are now well-established at the five oldest release sites. By 1991, 48 to 97% of the musk thistle at these sites were infested with these plant-feeding weevils. These high numbers may be the result of surviving progeny from three limited releases made in 1975.

Musk thistle, *Carduus thoermeri* Weinmann, was introduced into the United States from Europe more than 100 years ago (Rees 1982). Thistles compete with desirable grasses on thousands of hectares of pastures, and hinder the maintenance of roadways (Lambdin and Grant 1989). Musk thistle, which grows in many areas that are inaccessible and uneconomical for herbicide use, is a problem in many states and affects agricultural production (Grant *et. al.* 1990). Current mechanical and chemical management of musk thistle results in a substantial annual expenditure of time, labor, and money. In contrast, thistle-feeding weevil species have been released and established in several states including Maryland and Virginia, where they are estimated to save taxpayers ca. one million dollars annually (L. Kok and J. Tate, personal communication). Few native arthropod species have been found to cause serious damage to the reproductive capabilities of musk thistle in Tennessee (Powell *et al.* 1992), which supports the need to release the head weevil, *Rhinocyllus conicus,* Froelich (Coleoptera: Curculionidae), against infestations of musk thistle.

In 1975, 500 *R. conicus* adults were released at each of three sites in eastern Tennessee and one site in middle Tennessee (unpublished data). However, less than two dozen adults were recovered the following spring and no additional follow-up studies were made. The University of Tennessee Agricultural Experiment Station and the Tennessee Department of Transportation (TDOT) initiated a research program in 1989 directed at the management of musk thistle using plant-feeding insects. The ini-

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[2] Department of Entomology and Plant Pathology, University of Tennessee, Knoxville, TN 37901-1071

tial objective of this research was the introduction, release and establishment of an introduced plant-feeding weevil, *R. conicus,* in eastern and middle Tennessee.

MATERIALS AND METHODS

Release Areas: In 1989 and 1990, adult head weevils were obtained from Dr. Loke Kok (VPI & SU) and released (n=300-400/site) at thistle-infested sites in 11 counties in eastern and middle Tennessee (Fig. 1). These initial release sites were located along the interstate highway system (e.g., I-24, I-40, I-75, and I-81).

In 1991 and 1992, adult head weevils were collected from field insectaries established in 1989 in eastern Tennessee and released (n=75-100/site) at ca. 60 sites in 13 additional counties each year (Fig. 1). Release sites in 1991 and 1992 were located along selected highways and on private property (e.g., farms and nurseries). All release sites during each year were selected in cooperation with Tennessee Department of Transportation and the University of Tennessee Agricultural Extension Service.

Prior to releases in the field each year, weevils were collected, placed into cardboard containers (9.5 cm x 9.0 cm) with a moistened paper towel and foliage of musk thistle, and placed into an ice chest until their release

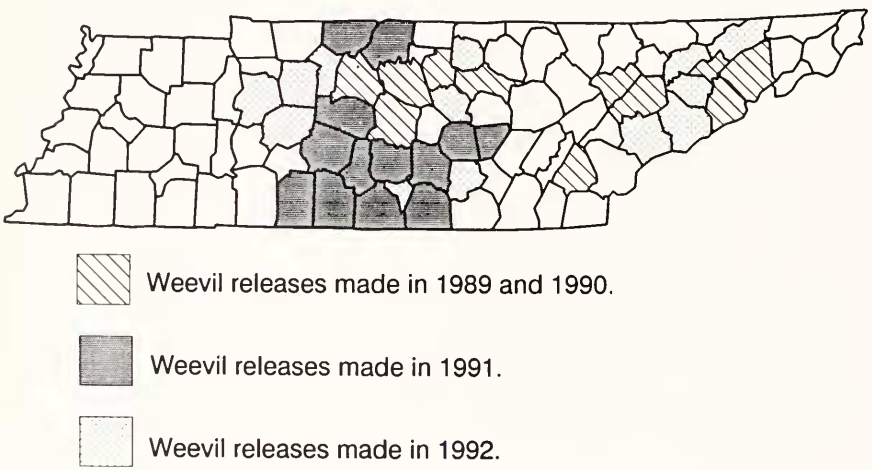

Figure 1. Locations of releases of *Rhinocyllus conicus* into counties in eastern and middle Tennessee, 1989-1992.

in the field. Weevils were released by opening the lid of the container and gently shaking the adult weevils onto developing buds of musk thistle at each site.

Monitoring Procedures: Each of the 1989 release sites was monitored twice monthly, and will continue to be monitored throughout the duration of this 6-year program. Plants were examined for the presence of head weevil adults and/or eggs (Fig. 2a and 2b, respectively). Infestation of musk thistle by the head weevil was easily determined by examining the undersurface of a bud or flower for eggs. The eggs are covered with masticated plant material and appear "wart-like" (Roberts and Kok 1979). The 1990, 1991 and 1992 release sites will be monitored in 2 to 5 years to evaluate weevil establishment at those sites.

RESULTS AND DISCUSSION

From 1989 to 1992, adult *R. conicus* were released at 132 selected sites along roadways and in pastures in 37 counties in eastern and middle Tennessee (Fig. 1). Weevil releases were concentrated in these two areas of the state because of abundant populations of musk thistle; this weed is rare in western Tennessee. As musk thistle spreads to other areas of the state, especially in western Tennessee, the weevils should move into these localized areas.

Progeny of head weevils released in 1989 and 1990 are well-established at the 1989 release sites. Although thistle density remained high by late spring in 1991 [6.4 (0.5-22) plants/m^2], 48 to 97% of the plants at the five most densely populated research sites were infested with eggs of these plant-feeding weevils (Fig. 3). Highest numbers of adults and eggs/plant were found at release sites in eastern Tennessee (sites 4, 5, and 7), possibly due to surviving weevil progeny from the 1975 releases. At several sites, 10 to 30 eggs per bud were observed (unpublished data). Upon dissection of these infested buds in mid-June, well developed larvae were found. Also, larvae were found within the stem about 2.5 to 5.0 cm below the bud. An infestation level of 10 to 15 larvae per bud can prevent seed production (Roberts and Kok 1979).

Populations of the head weevil are currently maintained at several field reservoir sites in eastern Tennessee. Individuals will be collected from these reservoir sites annually and transferred to other areas of the state until weevils are released and established in all thistle-infested counties in Tennessee. Infestations of weevils are expected to increase annually. About 5 years after release and establishment, population densities of *R. conicus* should increase substantially and reduce seed production and plant density (Kok and Pienkowski 1985, Surles and Kok 1976).

Figure 2. *Rhinocyllus conicus:* a) adult and b) eggs on undersurface of musk thistle bracts indicated by arrows.

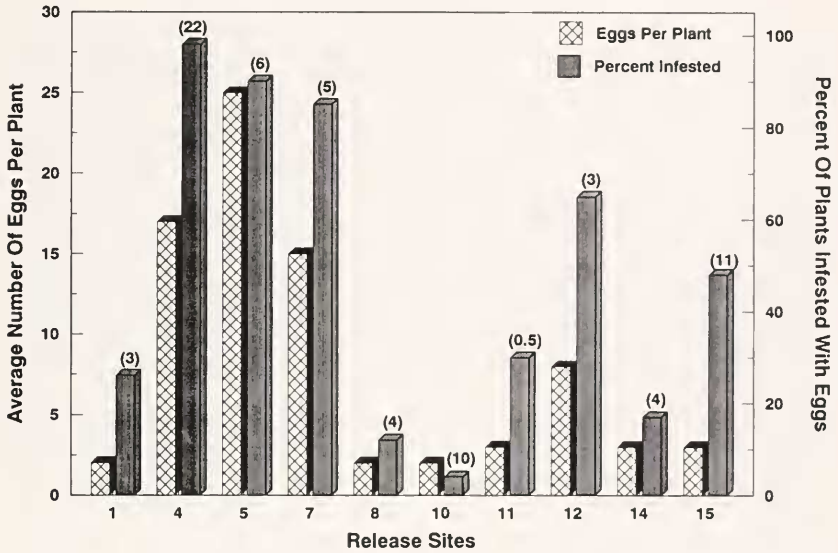

Figure 3. Densities of eggs of *Rhinocyllus conicus* and musk thistle at selected sites in eastern and middle Tennessee, 1991. Numbers in parentheses above bars represent density of musk thistle, (plants/m^2).

As fewer seeds are available for dispersal and fewer plants are present and visible, highway maintenance personnel and farmers can utilize their time and budget for other concerns.

The goal of this project is to reduce musk thistle infestations across the state to non-pest levels by incorporating the use of the biological control agent *R. conicus*. This management program should lead to a reduction in musk thistle populations and reduce the cost of thistle control. In addition, biological control offers an alternative means of pest suppression that is environmentally safe, compatible with other control tactics and provides a self-perpetuating, sustainable control system.

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